

Form 9-1366  
(Oct. 2005)

**U.S. Department of the  
Interior  
U.S. Geological Survey  
Joint Funding Agreement**

Customer #: NE030  
Agreement #: 08C4NE030042000  
Project #: 8626DHS  
TIN #: 47-6006256  
Fixed Cost Agreement ☒ Yes ☐ No

**FOR  
WATER RESOURCES INVESTIGATIONS**

THIS AGREEMENT is entered into as of the **10th** day of **July, 2008**, by the **U.S. GEOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF THE INTERIOR**, party of the first part, and the **CITY OF LINCOLN**, party of the second part.

1. The parties hereto agree that subject to availability of appropriations and in accordance with their respective authorities there shall be maintained in cooperation **water-quality monitoring to evaluate BMP effectiveness in the City of Lincoln, NE**, herein called the program. The USGS legal authority is 43 USC 36C; 43 USC 50; and 43 USC 50b.
2. The following amounts shall be contributed to cover all of the cost of the necessary field and analytical work directly related to this program. 2(b) includes In-Kind Services in the amount of \$0.

(a) \$19,740 by the party of the first part during the period  
**July 10, 2008 to October 31, 2009**

(b) \$99,360 by the party of the second part during the period  
**July 10, 2008 to October 31, 2009**

- (c) Additional or reduced amounts by each party during the above period or succeeding periods as may be determined by mutual agreement and set forth in an exchange of letters between the parties.
- (d) The performance period may be changed by mutual agreement and set forth in an exchange of letters between the parties.
3. The costs of this program may be paid by either party in conformity with the laws and regulations respectively governing each party.
4. The field and analytical work pertaining to this program shall be under the direction of or subject to periodic review by an authorized representative of the party of the first part.
5. The areas to be included in the program shall be determined by mutual agreement between the parties hereto or their authorized representatives. The methods employed in the field and office shall be those adopted by the party of the first part to insure the required standards of accuracy subject to modification by mutual agreement.
6. During the course of this program, all field and analytical work of either party pertaining to this program shall be open to the inspection of the other party, and if the work is not being carried on in a mutually satisfactory manner, either party may terminate this agreement upon 60 days written notice to the other party.
7. The original records resulting from this program will be deposited in the office of origin of those records. Upon request, copies of the original records will be provided to the office of the other party.

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8. The maps, records, or reports resulting from this program shall be made available to the public as promptly as possible. The maps, records, or reports normally will be published by the party of the first part. However, the party of the second part reserves the right to publish the results of this program and, if already published by the party of the first part shall, upon request, be furnished by the party of the first part, at costs, impressions suitable for purposes of reproduction similar to that for which the original copy was prepared. The maps, records, or reports published by either party shall contain a statement of the cooperative relations between the parties.
9. USGS will issue billings utilizing Department of the Interior Bill for Collection (form DI-1040). Billing documents are to be rendered quarterly. Payments of bills are due within 60 days after the billing date. If not paid by the due date, interest will be charged at the current Treasury rate for each 30 day period, or portion thereof, that the payment is delayed beyond the due date. (31 USC 3717; Comptroller General File B-212222, August 23, 1983).

U.S. Geological Survey  
United States  
Department of the Interior

City of Lincoln  
Watershed Management

USGS Point of Contact

Customer Point of Contact

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Signatures

Signatures

By Ronald B. Zelt Date 7-14-08  
Name: Ronald B. Zelt  
Title: Acting NWSC Director

By \_\_\_\_\_ Date \_\_\_\_\_  
Name: Chris Beutler  
Title: Mayor of Lincoln

By \_\_\_\_\_ Date \_\_\_\_\_  
Name:  
Title:

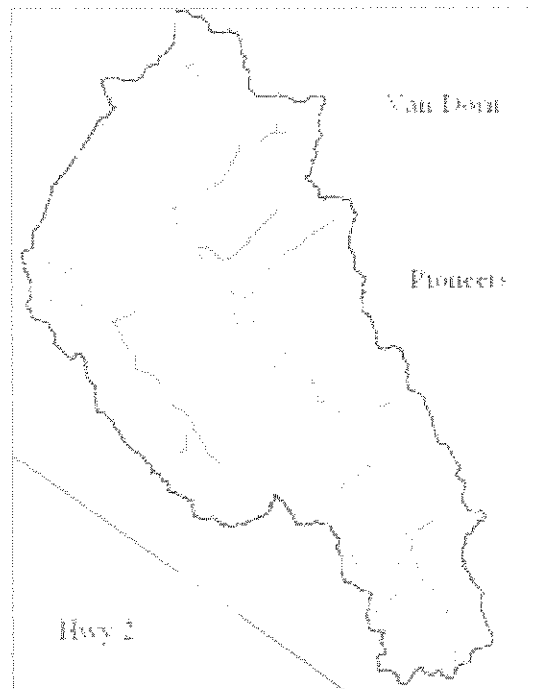
By \_\_\_\_\_ Date \_\_\_\_\_  
Name:  
Title:

# Water-quality monitoring to evaluate BMP effectiveness in the City of Lincoln, Nebraska

A collaborative study between the City of Lincoln, the Lower Platte South Natural Resources District, the University of Nebraska-Lincoln, and the U.S. Geological Survey Nebraska Water Science Center.

## Lower Platte South Natural Resources District

*To conserve, develop and manage the water and land resources of southeastern Nebraska for the common good.*



UNIVERSITY OF  
**Nebraska**  
Lincoln

**USGS**  
*science for a changing world*

**Preliminary proposal of USGS activities for data-collection efforts in calendar years 2008 and 2009.**

**Prepared by D.L. Rus**

**Version 20080603**

# Water-quality monitoring to evaluate BMP effectiveness in the City of Lincoln, Nebraska

## PROPOSAL - NE FY08

Prepared by: D.L. Rus, 06-03-2008

### SUMMARY

Best management practices (BMPs) have been implemented throughout the City of Lincoln, Nebraska, to reduce sediment and nutrient loading to streams in the area. However, the effectiveness of these BMPs is unclear. Therefore, the City of Lincoln (hereafter referred to as the City), the Lower Platte South Natural Resources District (hereafter referred to as the NRD), the University of Nebraska-Lincoln (hereafter referred to as UNL), and the U.S. Geological Survey Nebraska Water Science Center (hereafter referred to as the USGS) have proposed to enter into a collaborative partnership to study the effectiveness of BMPs. The study will use a 'paired watershed' approach by estimating pollutant loads (using continuous-water-quality parameters to develop surrogate relations) from one subwatershed in which BMPs have been emphasized and one subwatershed that has comparatively fewer BMPs. Those loads and yields will then be compared to identify differences related to BMPs or other factors within the subwatersheds. The study itself will serve in a BMP capacity through outreach by providing the data to the public via the internet.

Holmes Lake, an important flood-control and recreational resource in Lincoln, Nebraska, has been considered impaired regarding sediment and nutrients. In response, best management practices (BMPs) have been implemented throughout the Holmes Lake Watershed to reduce sediment and nutrient loading to the lake. As a result, one of the monitored subwatersheds will be within the Holmes Lake Watershed.

This study is intended to occur over a five-year period, beginning in late summer or fall 2008. Although the objectives and approach for the entire study are described, this initial agreement will only include the data-collection activities for calendar years 2008 and 2009. In general, UNL will be responsible for estimating streamflow and collecting water samples, the USGS will be responsible for collecting continuous-water quality data and transmitting the study data to the internet, and both USGS and UNL will collaborate on interpretive activities.

### PROBLEM

The City has the desire and requirement to estimate pollutant loads from discharges of its municipal separate storm drainage system (storm water separate from sanitary sewers) as Federally mandated by the Clean Water Act and subsequent National Pollutant Discharge Regulations. The development and implementation of a representative stormwater monitoring program will reduce the spatial and temporal variability of monitoring data. This will allow for a more robust monitoring data set to facilitate the identification of trends in pollutant loads over time, and to assist in improving BMP effectiveness.

Holmes Lake is an important resource in Lincoln, Nebraska, that provides flood control and multiple recreational opportunities. However, like many midwestern reservoirs, it is also subject to very high pollutant loads during rainfall-runoff events. This has caused Holmes Lake to be considered impaired with respect to nutrients and sediment, with Total Maximum Daily Loads (TMDLs) in place for each (Nebraska Department of Environmental Quality, 2004). In response, the City and its partners have instituted several BMPs throughout the watershed to reduce phosphorus and sediment loading to the lake. However, the effectiveness of these BMPs is unknown.

## **OBJECTIVES AND SCOPE**

This study will attempt to quantify the effectiveness of BMPs by estimating pollutant loads in paired watersheds. It will be a collaborative effort between the City, the NRD, the USGS, and UNL. The objectives of the study are as follows:

- Objective 1: To estimate pollutant loads from two watersheds within the City during non-winter periods. Both watersheds will be of similar size and urban character, but will have different BMP characteristics.
- Objective 2: To identify any differences in pollutant loads and yields from the two watersheds and to attempt to attribute those differences to the presence of BMPs.
- Objective 3: To disseminate the data collected in Objective 1 in a timely manner.

## **RELEVANCE AND BENEFITS**

The collaborating agencies wish to make the most efficient use of their resources and expertise by collaborating on a basis of mutual benefit. As stated earlier, the City has the desire and requirement to estimate pollutant loads from discharges of its municipal separate storm drainage system, to facilitate the identification of trends in pollutant loads over time, and to assist in improving BMP effectiveness. The NRD has the desire to cooperate with the City and share the City's goal of reducing pollutant loads from the City's municipal separate storm drainage system, which necessitates the need for representative stormwater monitoring data. UNL has a goal of providing educationally based service to the community.

The intent of this study is to characterize water-quality trends in Lincoln for the purpose of understanding and improving BMP effectiveness. In doing so, the proposed study satisfies two of the stated science goals of the USGS Nebraska Water Science Center (USGS, 2007): (1) Water-Quality Trends and Emerging Contaminants and (2) Integrated River System Assessments. Developing surrogate predictions for pollutants will lead to the implementation of an internet-display format similar to that being used by the USGS in Kansas (stated as a one-year action item in USGS, 2007) and the establishment of a real-time suspended-sediment monitoring site (stated as a three-year action item in USGS, 2007). In addition, this study will collect streamflow information, which will support the understanding of hydrologic hazards, another science goal (USGS, 2007).

## **APPROACH**

This study is intended to occur over a five-year period, beginning in late summer or fall 2008. Although the tasks associated with all components of the study are listed below, this initial agreement will only include the data-collection efforts of calendar years 2008 and 2009. The majority of USGS activities associated with this initial agreement will be focused on tasks 1.1, 1.3, 1.5, 2.2, 3.1, and 3.2; however, it is anticipated that other tasks will be included in future agreements. Because processing of collected data typically occurs following the field season, some costs will occur in Federal Fiscal Year 2010.

### **Objective 1—Pollutant Load Estimation**

The majority of resources required for this study are associated with estimating pollutant loads from the two watersheds. Monitoring will occur during non-winter periods (mid-March through mid-November) beginning in July 2008. It is hoped that this monitoring will continue until November 2011. There are 5 separate tasks associated with this objective:

### **Task 1.1—Site Selection**

The selection of suitable watersheds will be paramount to the success of this study, and will involve input from all partners. To the extent possible, site selection criteria will include: (1) BMP practices for both the Holmes Lake subwatershed and the control subwatershed will be known; (2) the two subwatersheds will be of comparable size; (3) the two subwatersheds will consist of comparable urban settings with the exception of BMP practices; (4) operation and maintenance of equipment at both monitoring sites will be logistically feasible (this constrains the study to monitoring sites on perennial reaches of streams).

### **Task 1.2—Continuous Streamflow Estimation**

Streamflow is the dominant variable that drives pollutant transport, and its estimation is critical to any load calculation. Streamflow will be estimated using methods that are based on the stage of the stream such as a weir at low streamflows and the Manning's equation at higher streamflows. The City will provide equipment for the continuous measurement of stage at both sites and will be responsible for site installation, with guidance from UNL and the USGS. The USGS will provide a data-collection platform for storing stage measurements. UNL will be responsible for estimating streamflow at both sites at a continuous interval. Monitoring will be seasonal, beginning in mid-March of each year and concluding in mid-November.

### **Task 1.3—Continuous Water-Quality Monitoring**

Several field parameters will be monitored continuously at both sites to serve as potential surrogates for estimates of pollutant concentrations. Field measurements will consist of:

- Water temperature,
- Specific conductance,
- Dissolved oxygen, and
- Turbidity.

The USGS will be responsible for this task, including the procurement of necessary equipment, the field operations, and the final publication of the data. Monitoring will follow the standard protocols listed in Wagner and others (2006). An optimal deployment configuration will be installed, routine maintenance will be performed to evaluate any fouling or calibration errors for each parameter, and necessary shifts will be applied to adjust the data accordingly. Monitoring will be seasonal, beginning in mid-March of each year and concluding in mid-November.

### **Task 1.4—Discrete Water-Quality Sampling**

A series of water-quality samples will be collected from both sites to: (1) satisfy regulatory requirements for stormwater sampling; and (2) compile 'calibration' data sets for use in developing relations of pollutant concentration to surrogate parameters collected as part of task 1.3. UNL will have primary responsibility for the completion of this task. Sampling will occur over a series of rainfall-runoff events, and will include the use of both autosampling equipment as well as grab sampling. To develop statistically valid surrogate relations, 30 or more samples over a range of streamflows (such as might be collected from an autosampler) and over a range of seasons will be collected. Sampling will be seasonal, beginning in mid-March of each year and concluding in mid-November.

### **Task 1.5—Estimation of Pollutant Loads**

Using the data collected in the preceding tasks, pollutant loads will be computed as the product of continuous estimates of streamflow and pollutant concentration. Pollutant concentrations will be estimated continuously by developing statistical-regression relations of surrogate-parameters (such as turbidity) to pollutant

concentrations using techniques similar to Rasmussen and others (2005) and Francy and Darner (2006). Because these relations are dependent on a comprehensive calibration data set, this task will not be performed in the first year of the study; however, because they are critical to the success of this study, they will be developed in the second and third year of the study. These relations will likely be published as an online-only version of the USGS Scientific Investigations Report (SIR) series.

## **Objective 2—Identifying and Explaining Differences in Pollutant Loads and Yields**

Identifying and explaining any differences in pollutant loads and yields between the two sites will be the key step in determining BMP effectiveness. Because this comparison will not be possible until pollutant loads have been estimated, accomplishing this objective will occur at the completion of the study.

### **Task 2.1—Compilation of Ancillary Data**

Spatial or time-series data that may be relevant to explaining trends or differences in pollutant yields between the two subwatersheds will be compiled. Examples of spatial data might include (but are not limited to) land use, structural BMPs, flow paths, and topographic relief. The City will provide most of these data from its existing library of spatial data. Examples of time-series data might include rainfall records (such as that available from the High Plains Regional Climate Center).

### **Task 2.2—Yield Comparisons**

Yields from both sites will be compared to identify differences. Yields on varying time-scales (by each event, by season, by year) will be compared anecdotally. Statistical tests of similarity will also be performed, and could involve (but are not limited to) paired-comparisons (using the student's *t* distribution), more general *t*-test comparisons on random subsets of the time-series data, or comparisons of the regression relations between sites. Yields from both sites will also be compared to various spatial indices (such as degree of urbanization, or number of BMPs per acre) to attempt to explain any yield differences between the sites. This will be a cooperative effort between USGS and UNL.

## **Objective 3—Disseminating the Data**

By making these data readily available to the public, this study will provide a social BMP through outreach to the community. It is hoped and expected that interest in these data will go beyond the partners. Providing a visual and near-real-time depiction of the stream response to land management may inspire changes in land practices by members of the public.

### **Task 3.1—Providing Public Access in Near-Real Time Over the Internet**

The USGS will utilize its existing infrastructure for transmitting time-series data in near-real time over the internet. At each site, the USGS will install data-collection platforms (DCPs) in gage houses provided by the City. At a set interval (15 to 60 minutes), the DCP will record and store data from the continuous water-quality monitor and the stage-monitoring equipment. The DCP will then transmit those data at least every four hours to the internet via the GOES satellite network. Once surrogate relations have been developed and approved (see task 1.5), the USGS will also provide, in near-real time, the predicted concentrations and loads associated with specific pollutants over the internet.

### **Task 3.2—Publication of Data**

The USGS will be responsible for the release of the stream-stage and continuous water-quality data to the public. These data will be published yearly in the Annual Data Report released in the spring of each year. Because streamflow and discrete-water-quality-sampling data will be determined from non-USGS sources, they will not be archived in the National Water Information System database of the USGS. Instead, those data will be published and archived via one of the partner organizations.

### **Task 3.3—Development of a Kiosk Display (Optional)**

Because of the high visibility of Holmes Lake as an urban-recreational area, the proposed study provides an excellent opportunity for outreach through the development of a kiosk-style display that could serve the near-real-time data as well as provide an overview of the study; however, this task is optional and will not be considered in the first year of the study in order to refine the data-collection activities.

## **QUALITY-ASSURANCE PLAN**

Continuous water-quality monitoring will be the primary data-collection activity for the USGS. These data will be collected and processed according to the protocols set forth in Wagner and others (2006). Data not meeting criteria set forth in those protocols (whether related to fouling from algae/debris or calibration drift) will not be published. In addition, continuous-stage data will be verified during each field visit by establishing a reference mark for tapedown measurements or the installation of a staff gage.

Because ammonia is a constituent of concern to the partners, the inclusion of an ammonia-specific probe with the continuous monitoring was explored. However, past field experience by the USGS suggests that this type of probe can not meet USGS quality-assurance standards. As a result, this probe will not be included in the sensor array.

Though not explicitly responsible for streamflow and discrete-water-quality-sample data, the USGS will help to ensure the quality of these data. The inclusion of specific conductance on the continuous-water-quality monitor affords the unique ability to quickly estimate streamflow using tracer techniques (Kilpatrick and Cobb, 1985), and these activities will be included in the field visits. Guidance on proper-sampling techniques will be provided and a quality-control strategy will be recommended.

After the first season of data collection, the quality of the data will be reviewed, and any appropriate changes to the approach will be discussed and possibly implemented. Precision or bias in any of the data components will be characterized and documented accordingly.

## **PRODUCTS**

As stated earlier, the USGS will be responsible for the release of stream stage and continuous-water-quality data to the public. These data will be published yearly in the Annual Data Report released in the spring of each year. Once surrogate relations have been established as part of task 1.5, these relations will be released in a USGS SIR. Having these relations published will afford the ability to provide near-real time estimates of pollutant concentration and loads for the remainder of the study. In the final year of the study, the USGS will collaborate on at least one journal article summarizing the results of the study.

## **REFERENCES**

- Francy, D.S., and Darner, R.A., 2006, Procedures for developing models to predict exceedances of recreational water-quality standards at coastal beaches: U.S. Geological Survey Techniques and Methods 6-B5, 34 p.
- Kilpatrick, F.A., and Cobb, E.D., 1985, Measurement of Discharge Using Tracers: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter A16, 63 p.



Nebraska Department of Environmental Quality, 2004, 2004 Surface Water Quality Integrated Report: Nebraska Department of Environmental Quality, Lincoln, Nebr., 109 p., accessed April 18, 2008 at url: <http://www.deq.state.ne.us/>

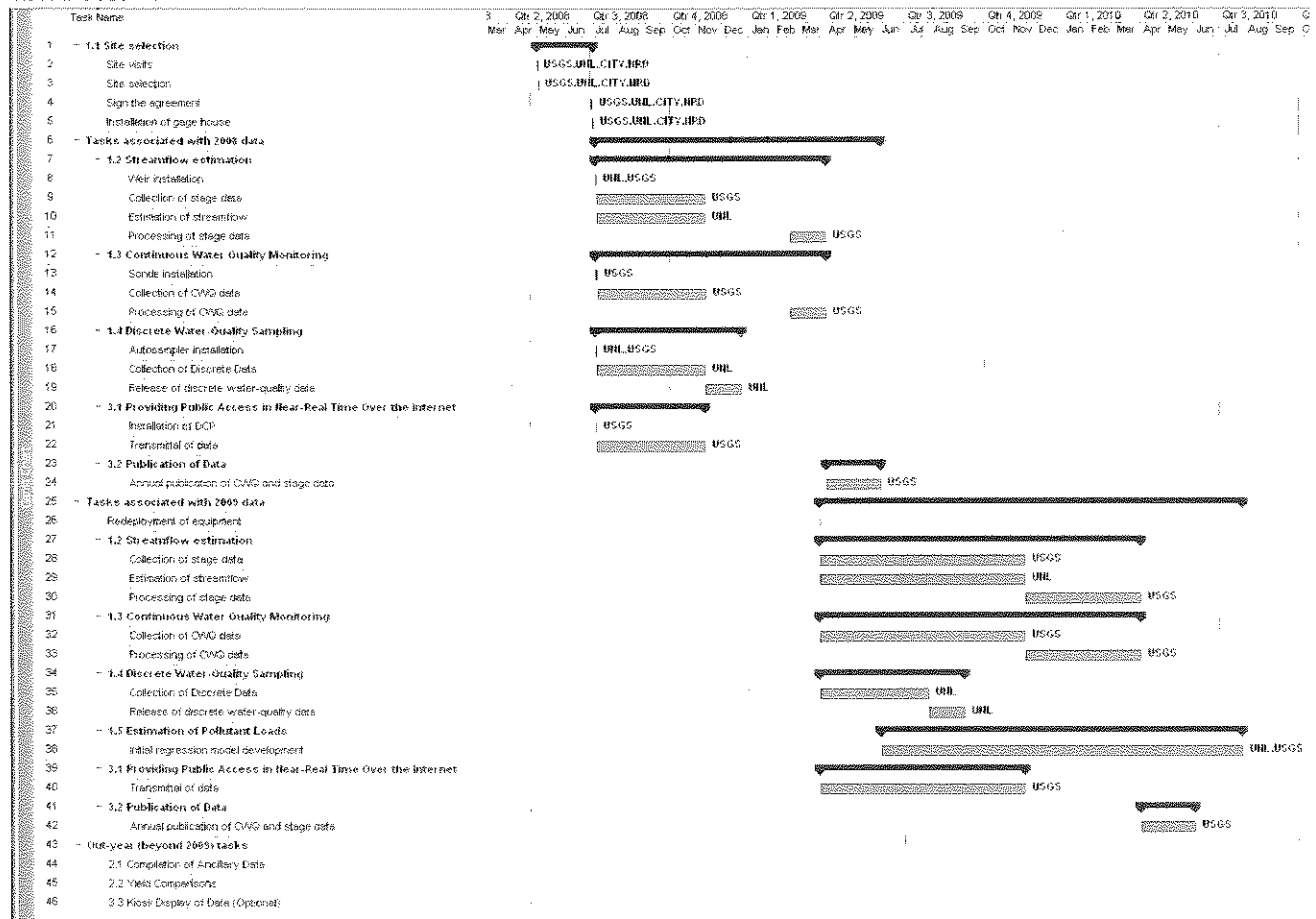
Rasmussen, T.J., Ziegler, A.C., and Rasmussen, P.P., 2005, Estimation of constituent concentrations, densities, loads, and yields in lower Kansas River, northeast Kansas, using regression models and continuous water-quality monitoring, January 2000 through December 2003: U.S. Geological Survey Scientific Investigations Report 2005-5165, 117 p.

Wagner, R.J., Boulger, R.W., Jr., Oblinger, C.J., and Smith, B.A., 2006, Guidelines and standard procedures for continuous water-quality monitors—Station operation, record computation, and data reporting: U.S. Geological Survey Techniques and Methods I-D3, 51 p. + 8 attachments.

USGS, 2007, USGS Nebraska Water Science Center Science Plan, 2007: USGS, Reston, Virginia, 21 p., accessed April 22, 2008 at url: [http://ne.water.usgs.gov/usgs/documents/NE%20Science%20Plan-041207\\_final.pdf](http://ne.water.usgs.gov/usgs/documents/NE%20Science%20Plan-041207_final.pdf)

## WORK PLAN

Although all components of the proposed study have been described here, the initial agreement will consist of activities associated with data collection in 2008 and 2009. The workplan for these data-collection efforts are listed below.



Gantt chart describing study activities associated with 2008 and 2009 data-collection efforts.

## PERSONNEL

Personnel requirements are estimated for the entire study period; however, the initial agreement will be constrained to activities related to 2008 and 2009 data collection.

### Personnel requirements by federal fiscal year (October 1 through September 30) for data collection efforts of 2008 and 2009, in days.

Personnel	FY2008	FY2009	FY2010	FY2011	FY2012
Senior hydrologist (GS-12)	16	42	39	37	69*
Hydrologic technician (GS-11)	4	15	6	6	0
Hydrologic technician (GS-07)	8	28	33	33	20
Hydrologic assistant (GS-05)	11	20	20	20	0

\*Collaborative roles have not yet been formally established between the USGS and UNL for the interpretive component of the study. Therefore, this value is likely to change.

## BUDGET

Budgetary estimates are projected for the entire study; however, the initial agreement will be constrained to activities related to 2008 and 2009 data collection, and costs will be related to those efforts only. Cooperative funding by the USGS is included at \$2,500 in 2008, \$17,240 in 2009, and will be made at a 20 percent match of total funding in out years.

### Budget breakdown by federal fiscal year (October 1 through September 30).

Cost	FY 2008	FY 2009	FY 2010	FY2011	FY2012
Labor	\$19,900	\$76,800	\$71,900	\$74,600	\$99,300*
Equipment and Supplies	\$7,300	\$14,100	\$15,700	\$16,500	\$0
Publication	\$0	\$0	\$5,800	\$0	\$0
Total	\$27,200	\$91,900	\$93,400	\$91,100	\$99,300*

Funding	FY 2008	FY 2009	FY 2010	FY2011	FY2012
City of Lincoln, LPS NRD	\$24,700	\$74,660	\$74,720	\$72,880	\$79,440*
USGS	\$2,500	\$17,240	\$18,860	\$18,220	\$19,860*
Total	\$27,200	\$91,900	\$93,400	\$91,100	\$99,300*

\*Collaborative roles have not yet been formally established between the USGS and UNL for the interpretive component of the study. Therefore, this value is likely to change.

## SAFETY

All field activities will be designed to minimize the risks to personnel. This will be accomplished according to the procedures listed in the attached job hazard analyses.